CLAIMS

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is as follows:

1. A method of protecting a flowable oxide in a semiconductor device, said method including the steps of

depositing a flowable oxide insulator layer on a substrate, said substrate having a substrate surface and a stud, said stud being electrically conductive, said flowable oxide insulator layer having a upper FOX insulator layer surface,

etching said flowable oxide insulator layer to form a trough substantially defined by sidewalls of said flowable oxide insulator layer and by said substrate surface, said trough exposing said stud,

forming a primary protective layer on said sidewalls of said flowable oxide insulator layer, said primary protective layer preventing the exposure of the flowable oxide insulator layer to moisture and lithographic resist developers, said primary protective layer being impervious to copper extrusion, and

forming a secondary protective layer in said trough upon said primary protective layer and upon said substrate surface, said secondary protective layer being in electrical communication with said stud.

2. The method of protecting a flowable oxide as claimed in claim 1, wherein the step of etching the flowable oxide insulator layer to form a trough forms a plurality of troughs, each one of said plurality of troughs defined by said sidewalls of said flowable oxide insulator layer and by said substrate surface.

3. The method of protecting a flowable oxide as claimed in claim 1, wherein said primary protective layer is discontinuous within said trough and said secondary protective layer is continuous within said trough.

4. The method of protecting a flowable oxide as claimed in claim 1, further comprising the step of oxidizing said upper FOX insulator layer surface, thereby forming a oxidized FOX layer.

5. The method of protecting a flowable oxide as claimed in claim 4, wherein said upper FOX insulator layer surf ace is oxidized in an 02 plasma.

6. The method of protecting a flowable oxide as claimed in claim 4, wherein said oxidized FOX layer is less than 500 Angstroms thick.

7. The method of protecting a flowable oxide as claimed in claim 4, further comprising the step of forming a oxide layer on said oxidized FOX layer.

8. The method of protecting a flowable oxide as claimed in claim 7, wherein said oxide layer is formed by low plasma chemical vapor deposition.

9. The method of protecting a flowable oxide as claimed in claim 7, wherein said trough is formed after said oxidized FOX layer is formed and after said oxide layer is formed.

10. The method of protecting a flowable oxide as claimed in claim 9, wherein said primary protective layer is formed by oxidizing said sidewalls of said flowable oxide insulator layer.

11. The method of protecting a flowable oxide as claimed in claim 9, wherein said trough is formed by a reactive ion etch with fluorocarbon gases and said primary protective layer is formed during said reactive ion etch.

12. The method of protecting a flowable oxide as claimed in claim 9, wherein said primary protective layer is formed by the same process used to form said oxidized FOX layer.

13. The method of protecting a flowable oxide as claimed in claim 9, wherein said primary protective layer is less than 500 Angstroms thick.

14. The method of protecting a flowable oxide as claimed in claim 9, further comprising the steps of depositing a conductor in said trough and smoothing

said conductor and said oxide layer thus forming an even planar surface by said conductor and said oxide layer, said conductor being in electrical communication with said secondary protective layer.

15. The method of protecting a flowable oxide as claimed in claim 14, wherein said conductor is copper.

16. The method of protecting a flowable oxide as claimed in claim 14, wherein said step of smoothing said conductor and said oxide layer is performed by polishing.

17. The method of protecting a flowable oxide as claimed in claim 14, further comprising the steps of

depositing a nitride layer on said even planar surface,

depositing another flowable oxide insulator layer on said nitride layer, said another flowable oxide insulator layer having another upper FOX insulator layer surface,

oxidizing said another upper FOX insulator layer surface, thereby forming another oxidized FOX layer,

forming another oxide layer on said another oxidized FOX layer,

etching said another oxide layer, said another oxidized FOX layer, said another flowable oxide insulator layer, and said nitride layer to form another trough substantially defined by another

sidewalls of said another flowable oxide insulator layer and by said even planar surface,

forming another primary protective layer on said another sidewalls of said another flowable oxide insulator layer, said another primary protective layer preventing the exposure of said another flowable oxide insulator layer to moisture and lithographic resist developers, said another primary protective layer being impervious to copper extrusion,

forming another secondary protective layer in said another trough upon said another primary protective layer and upon said even planar surface, said another secondary protective layer being in electrical communication with said conductor,

depositing another conductor in said another trough, said another conductor being in electrical communication with said another secondary protective layer, and

smoothing said another conductor and said another oxide layer thus forming another even planar surface by said another conductor and said another oxide layer.

18. The method of protecting a flowable oxide as claimed in claim 17, wherein said another oxide layer is thicker than said oxide layer.

19. The method of protecting a flowable oxide as claimed in claim 17, wherein said another flowable oxide insulator layer is thicker than said flowable oxide insulator layer.

20. The method of protecting a flowable oxide as claimed in claim 19, wherein said another trough has multifaceted contours.

21. The method of protecting a flowable oxide as claimed in claim 17, wherein said secondary protective layer and said another secondary protective layer are formed from Tantalum Nitride/Tantalum.

22. A method of protecting a flowable oxide in a semiconductor device, said method including the steps of

depositing a flowable oxide insulator layer on a substrate, said substrate having a substrate surface and a stud, said stud being electrically conductive, said flowable oxide insulator layer having an upper FOX insulator layer surface,

etching the flowable oxide insulator layer to form a trough defined by sidewalls of said flowable oxide insulator layer and by said substrate surface, said trough exposing said stud,

forming a primary protective layer on said sidewalls of said flowable oxide insulator layer, said primary protective layer preventing the exposure of the flowable oxide insulator layer to moisture and lithographic resist developers, said primary protective layer being impervious to copper extrusion,

forming a supplemental protective layer on said primary protective layer, said supplemental

protective layer being impervious to moisture, lithographic resist developers, and copper extrusion, said supplemental protective layer improving adhesion with a metallic conductor, and

forming a secondary protective layer in said conductive trough upon said supplemental protective layer and upon said substrate surface, said secondary protective layer being in electrical communication with said stud.

23. The method of protecting a flowable oxide as claimed in claim 22, wherein said supplemental protective layer is formed by nitridizing said primary protective layer.

24. The method of protecting a flowable oxide as claimed in claim 22, wherein said supplemental protective layer is formed by treating said primary protective layer with silicon carbide.

25. The method of protecting a flowable oxide as claimed in claim 22, wherein said supplemental protective layer is formed by treating said primary protective layer with silicon nitride.

26. The method of protecting a flowable oxide as claimed in claim 22, wherein said primary protective layer and said supplemental protective layer are discontinuous within said trough and said secondary protective layer is continuous within said trough.

27. An integrated circuit semiconductor device including

a substrate having a substrate surface,

a flowable oxide insulator layer upon said substrate surface,

a trough,

sidewalls of said flowable oxide insulator layer,

a primary protective layer on said sidewalls of said flowable oxide insulator layer, said primary protective layer preventing the exposure of said flowable oxide insulator layer to moisture and lithographic resist developers, said primary protective layer being impervious to copper extrusion, and

a secondary protective layer on said primary protective layer and on said substrate surface, said secondary protective layer being electrically conductive.

28. The integrated circuit semiconductor device as claimed in claim 27, further comprising,

an oxidized FOX layer upon said flowable oxide insulator layer,

an oxide layer upon said oxidized FOX layer,

a conductor in said trough, said conductor and said oxide layer forming an even planar surface, said conductor being in electrical communication with said secondary protective layer, and

a nitride layer upon said even planar surface.

29. The integrated circuit semiconductor device as claimed in claim 28, further comprising a second damascene layer, said second damascene layer comprising,

another flowable oxide insulator layer upon said nitride layer,

another oxidized FOX layer upon said another flowable oxide insulator layer,

another trough,

another sidewalls of said another flowable oxide insulator layer,

another primary protective layer upon said another sidewalls, said another primary protective layer preventing the exposure of said another flowable oxide insulator layer to moisture and lithographic resist developers, said another primary protective layer being impervious to copper extrusion,

another secondary protective layer upon said another primary protective layer and upon said even planar surface, said another secondary protective layer being in electrical communication with said conductor, and

another conductor in said another trough, said another conductor being in electrical communication with said another secondary protective layer.

30. The integrated circuit semiconductor device as claimed in claim 29, wherein said another trough is a dual damascene trough.

31. The integrated circuit semiconductor device as claimed in claim 27, further comprising a supplemental protective layer on said primary protective layer, said supplemental protective layer being impervious to moisture, lithographic resist developers, and copper extrusion, said supplemental protective layer improving adhesion with a metallic conductor.